(12) UK Patent Application (19) GB (11) 2 011 506 A

(21) Application No 7850025
(22) Date of filing 27 Dec 1978
(23) Claims filed 27 Dec 1978
(23) Claims filed 23 Mar 1979
(30) Priority data
(31) 7739849
(32) 30 Dec 1977
(33) France (FR)
(43) Application published
11 Jul 1979
(51) INT CL²
E21B 43/01
(52) Domestic classification
E1F 42 44
B8E 10
F2G 1F 35
(56) Documents cited
None
(58) Field of search
E1F
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(54) Mooring and Transfer Terminals for Offshore Hydrocarbon Production

(57) A mooring and transfer terminal (1) for offshore hydrocarbon production comprises a watertight caisson (2) surrounded by a rotatable arm (5) which supports a pipe (9) for loading oil tankers (8). The caisson (2) houses manifolds and a T.F.L. (Through Flow Line) switching device connected to different underwater producing wellheads (10, 11, 12). A T.F.L.—servicing pipe (23) supported by the rotatable arm (5) and connected to the switching device by a rotary coupling at the top of the caisson (2) permits introduction of T.F.L. tools or instruments from the surface of the water into a selected well through the switching device. The switching device can include a rotatably mounted member having a curved conduit for selective connection to one of a number of apertures in the mounting.

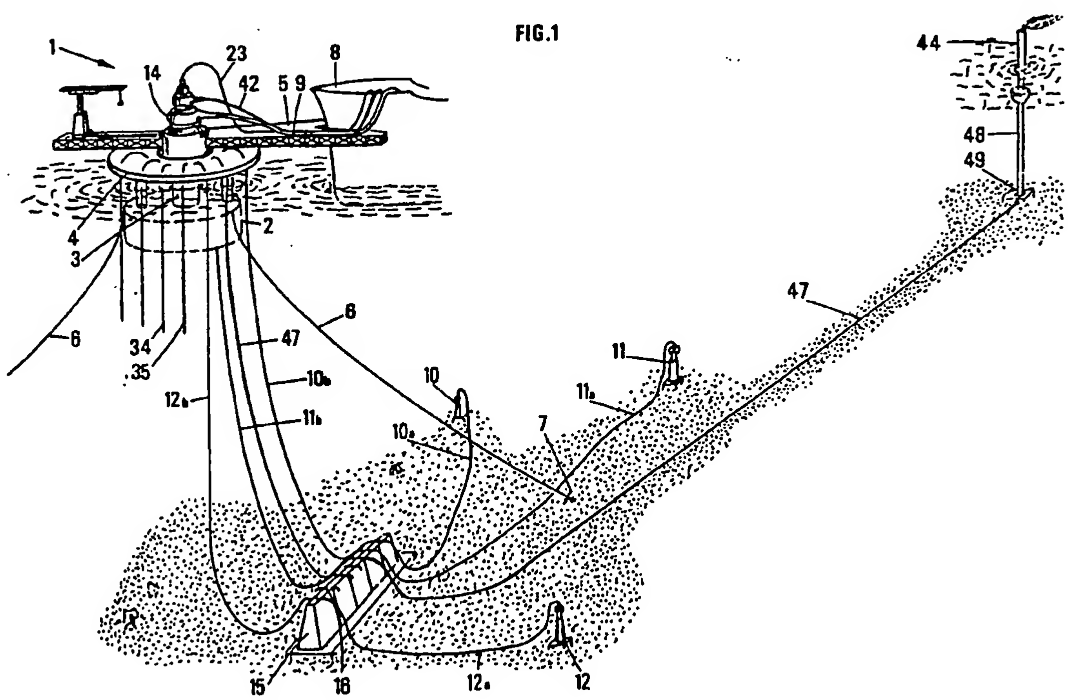

FIG.1

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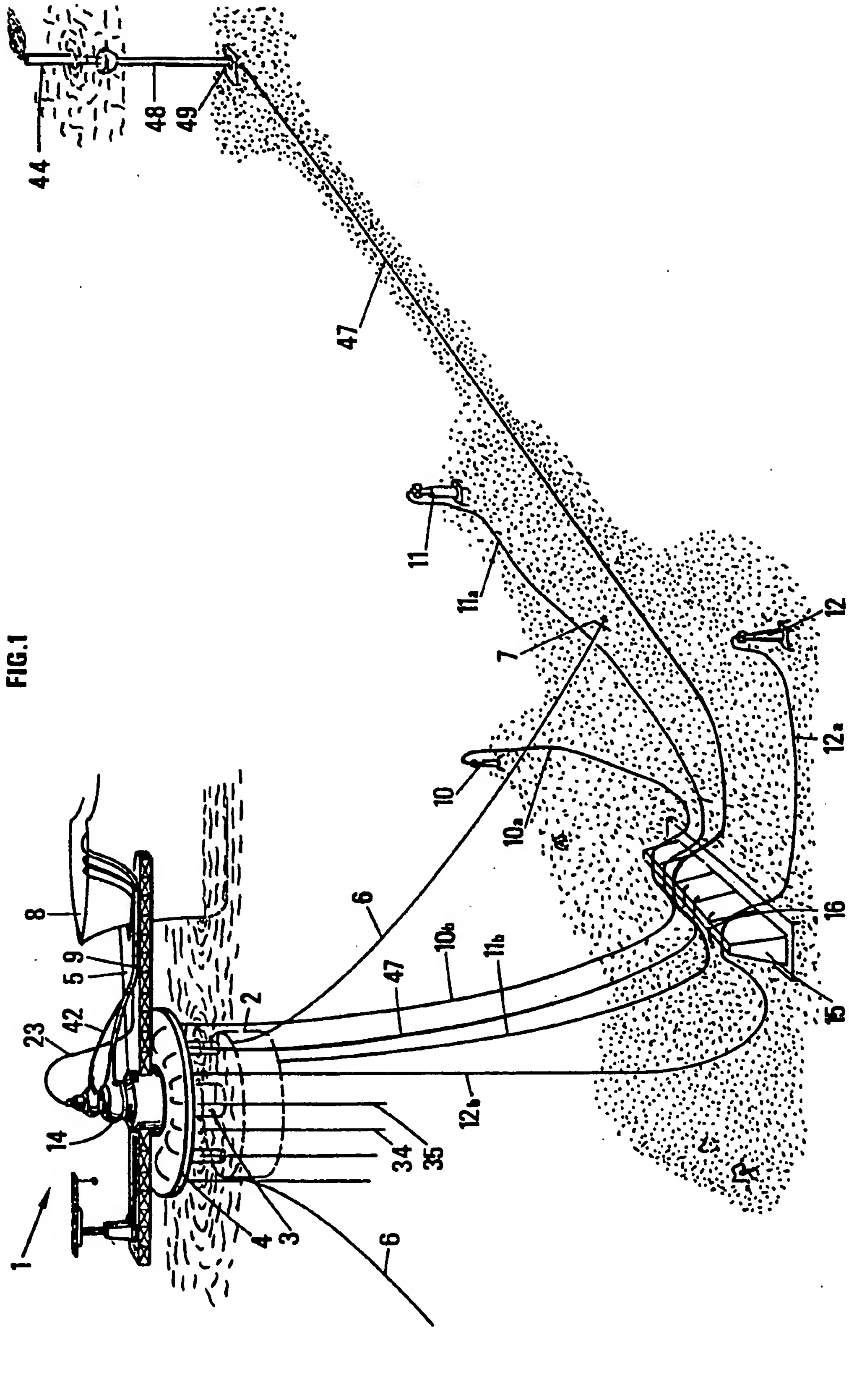
1
4
3
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14
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10b
11b
12b
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11
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12
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16
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47
44
48
49

FIG.1

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FIG.2

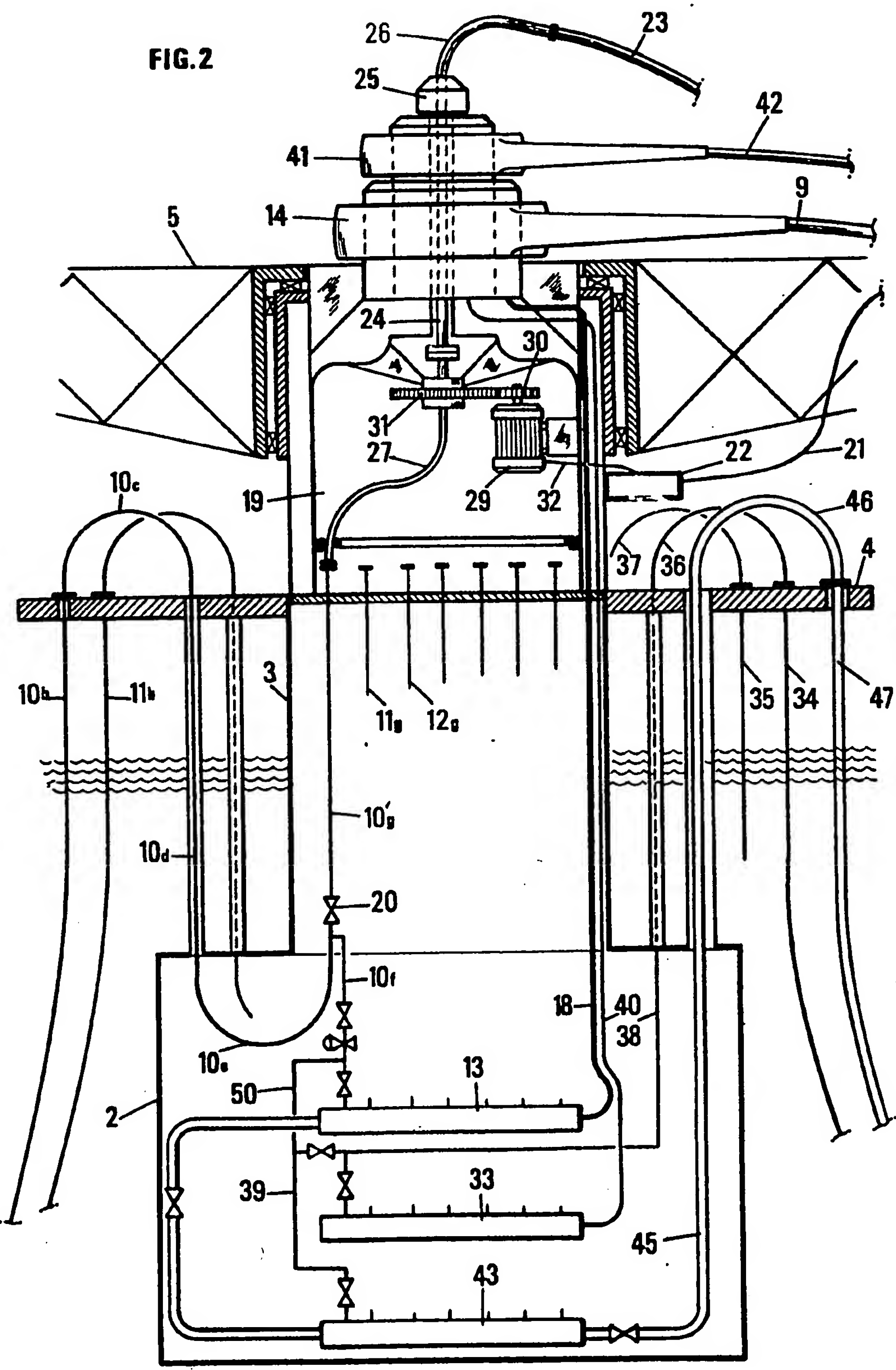


FIG.3

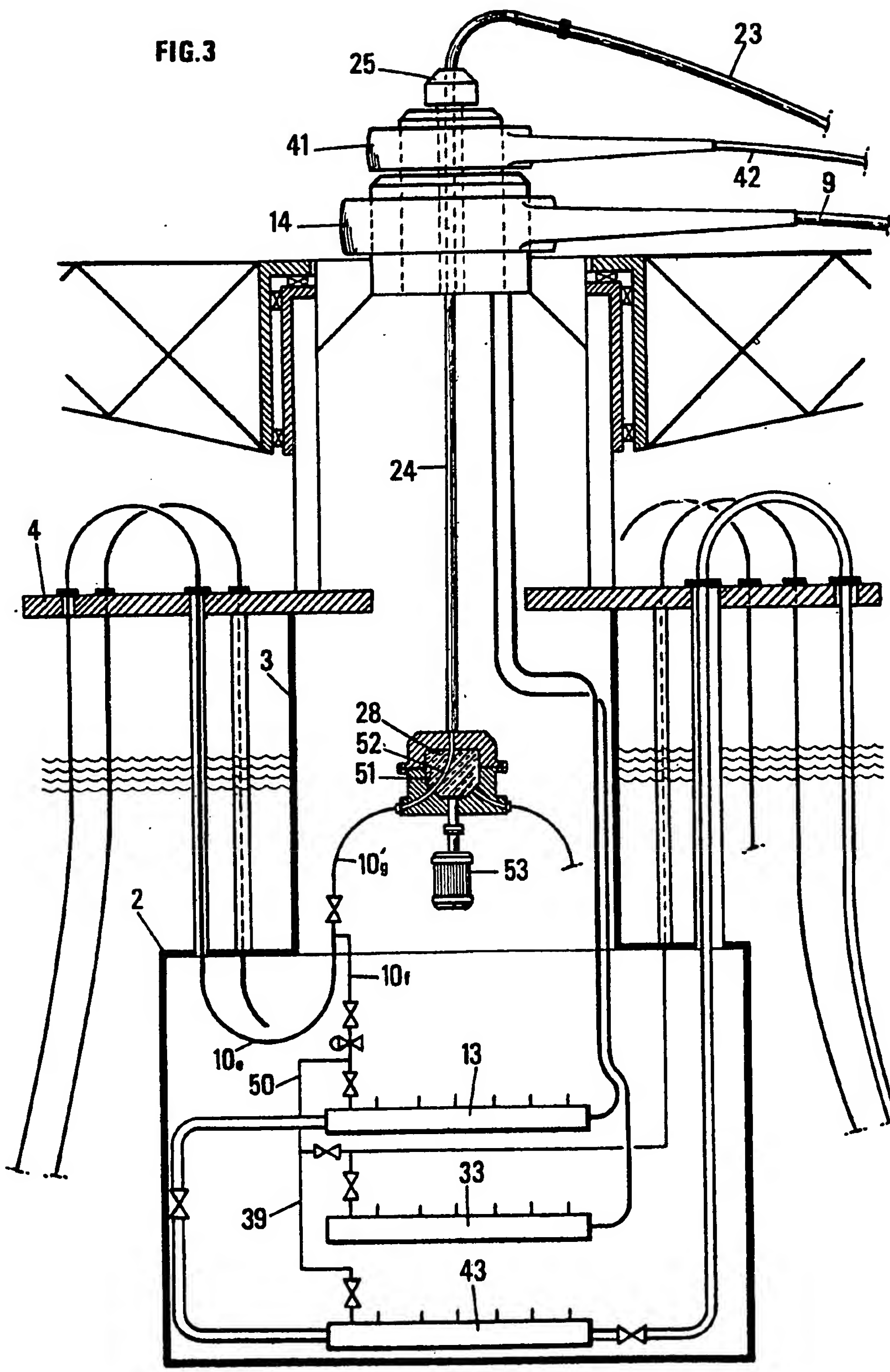


FIG.4A

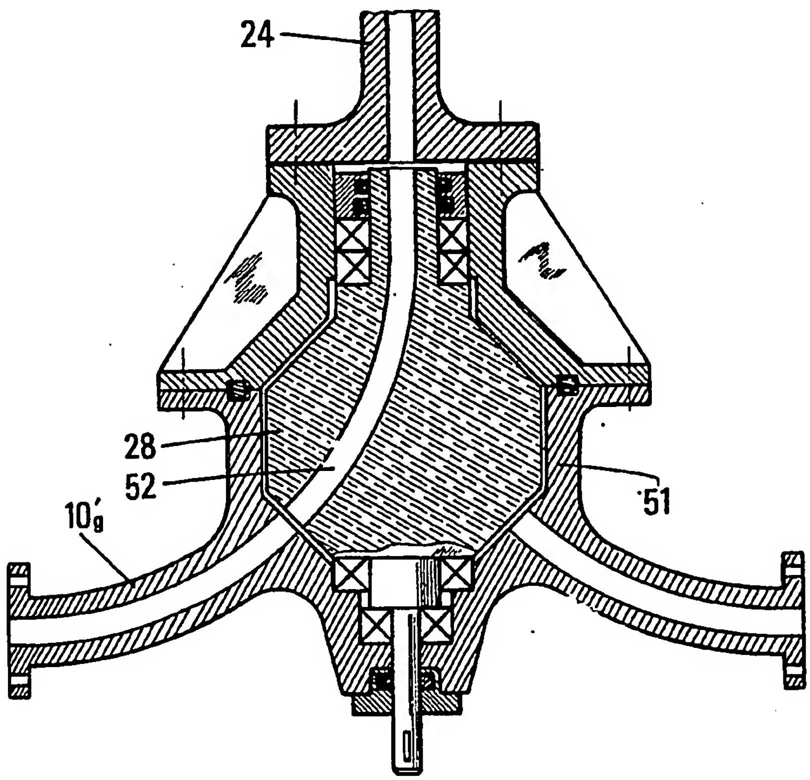
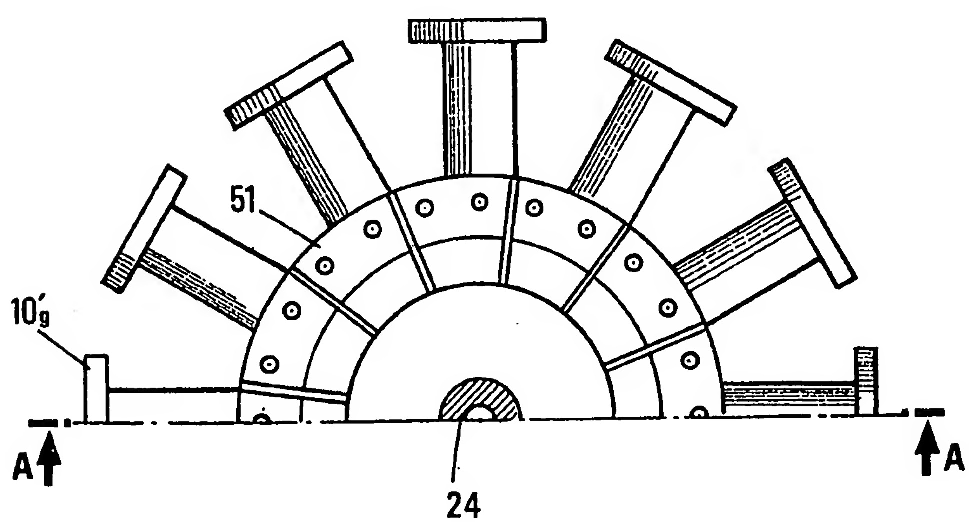


FIG.4



SPECIFICATION

Mooring and Transfer Terminals for Offshore Hydrocarbon Production

This invention relates to mooring and transfer terminals for offshore hydrocarbon production, such terminals permitting the mooring of oil processing and transportation ships.

At the present time offshore hydrocarbon production is developing at locations remote from conventional harbours and this, added to the continuous weight increase of oil tankers, leads to the building of artifical mooring stations or terminals for anchoring such tankers during loading operations thereof.

Known mooring and transfer terminals are connected to a plurality of underwater production wellheads and comprise a caisson topped by a rotatable arm which supports at least one loading pipe for loading oil tankers. In these known arrangements the different producting wellheads are connected by pipes to a production manifold which rests on the water bottom. This manifold can be connected to the caisson by a gathering line laying on the water bottom and a riser connecting the gathering line to the loading pipe supported by the caisson.

According to the present invention there is provided a mooring and transfer terminal for offshore hydrocarbon production from a plurality of underwater wells, the terminal comprising a watertight caisson surmounted by a rotatable arm which supports at least one loading pipe, at least one production manifold connecting the different wells to said loading pipe, at least one circulation and safety manifold connecting the different wells to a circulation and safety pipe means which is common to all the wells, said manifolds being equipped with valve means, and switching means located in a sealed chamber and enabling a conduit for introducing T.F.L. instruments to be connected to a pipe selected from a plurality of circulation and T.F.L. servicing pipes connecting the different wells both to said switching means and to said production manifold, the assembly of said manifolds and of said switching means being located in the watertight caisson, said manifolds and said switching means being connected to the different wells by flexible pipelines, and said conduit for introducting T.F.L. tools and said circulation and safety pipe means being supported at the surface of the water by the rotatable arm surmounting the caisson.

Preferred embodiments of the invention described below can enable maintenance operations to be performed on the production manifold more easily and less expensively. The preferred embodim nts facilitate the performance of servicing operations on the producing underwater wells, more particularly the introduction of tools or instruments into production conduits, by pumping such tools or instruments in a direction opposite to the direction of flow through production tubing, down to the bottom of a preselected producing well. This pumping process is th well known T.F.L. (Through Fl w Line) method.

As compared to prior art systems wherein the manifolds lie on the water bottom, the terminals embodying the invention have the advantage of locating the manifolds in the watertight caisson, i.e. in a dry atmosphere. This may increase the working life of the manifolds and of electrical and hydraulic equipment associated therewith, and faciliates maintenance of such equipment.

The terminals embodying the invention have the additional advantage of being easily retrievable, so as to be transferred to another production site.

The invention will now be further described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is an overall view of a mooring and transfer terminal embodying the invention;

Figure 2 diagrammatically shows a caisson of the mooring and transfer terminal in axial section;

Figure 3 illustrates another embodiment wherein a switching means comprises a rotatable drum;

Figure 4 is a half-view from above of an embodiment of the rotatable drum; and

Figure 4A shows the same rotatable drum in axial section.

In the drawings, reference numeral 1 designates as a whole a mooring and transfer station or terminal comprising a watertight caisson 2 immersed at a shallow depth, the caisson supporting by means of a column 3 a crown-shaped platform 4 on which an arm 5 is rotatably mounted.

In the illustrated preferred embodiment, the caisson 2 is of positive buoyancy and is held in position by moorings 6 and anchors 7, but it would be possible, without deparating from the scope of the invention, to secure the caisson 2 to the top of a structure such as, for example, a pile driven into the water bottom or resting on the water bottom by means of a base plate.

The rotatable arm 5 permits mooring of an oil tanker 8 and loading thereof with hydrocabons through one or more flexible loading pipes 9 supported by the arm. The loading pipes 9 can be connected by suitable means to the tanks of the ship 8.

A plurality of different producing wellheads, such as 10, 11 and 12, are connected by flexible pipe flow lines 10*a*, 11*a*, 12*a*, . . . and flexible pipe risers 10*b*, 11*b*, 12*b* to a production manifold 13 (Figure 2), inside the caisson 2, which communicates with the flexible loading pipe 9 via a rotary coupling 14.

In the embodiment illustrated in Figure 1, the flexible pipes 10*a* and 10*b* are locally supported, in the vicinity of the water bottom, by guide means comprising for example a support member 15 on which are located guide elements 16 with curved rims limiting the b nding stresses in the flexible pipes at this location.

As shown in Figure 2, the production manifold 13 inside the caisson 2 is connected to the

different underwater pr duction well-heads via the risers 10*b*, 11*b* ... etc. Th se risers drain th hydrocarbon production and nable T.F.L. (Through Fl w Line) t ols or instruments to be injected or forced by counterflow pumping.

The production manifold 13 is connected to the loading pipe 9 via the rotary coupling 14 and a conduit 18.

A flexible production riser, such as the riser 10*b*, is connected to the manifold 13 via rigid conduits or tubular elements such as 10*c*, 10*d*, 10*e* and 10*f* (Figure 2).

The radius of curvature of the conduits such as 10*c* and 10*e*, as well as that of the rims of the guide elements 16 located in the vicinity of the water bottom, is selected to be sufficient for avoiding jamming of special T.F.L. tools or instruments (scraping tools or measuring instruments, for example) in these tubular connecting elements, or in pipelines such as 10*b*, 11*b*..., 10*a*, 11*a*...

To permit application of the T.F.L. method, the curved connecting conduits such as the conduit 10*e* are tangentially connected to a plurality of rectilinear substantially vertical pipes 10*g*, 11*g*, 12*g* etc. corresponding to the different production wells, these different vertical pipes opening in a chamber 19 located above the platform 4.

The vertical pipes 10*g*, 11*g*, 12*g*, etc. comprise T.F.L. valves 20 which are normally closed when the wells are producing and which, together with other valves of the installation, are remotely actuated for the surface by means of a remote control and power line 21 supported by the rotatable arm 5 and connected to a central station 22 from which the different valves can be remotely controlled. The connection between the central station 22 and the valves has not been shown in Figure 2 for the sake of clarity.

Without interrupting the production of the other wells whose T.F.L. valves 20 remain closed, it is possible to introduce from the surface of the water into one of the wells a tool or instrument according to the T.F.L. methods, through a flexible T.F.L. servicing pipe 23.

The flexible pipe 23 is connected to a conduit 24 positioned along the axis of the chamber 19, via a rotary coupling 25 and a connecting pipe 26 whose raduis of curvature is sufficient to prevent any risk of jamming of the T.F.L. tools or instruments.

The introduction of these tools or instruments into any of the pipes 10*g*, 11*g*, 12*g* etc. corresponding to a selected well is achieved through an S-shaped conduit 27 forming a switch and connecting this pipe to the axial conduit 24, the conduit 27 being rotatably mounted about the axis f the chamber 19.

The conduit 27 is, for example, positioned by means of a motor 29 driving gears 30 and 31, electric or hydraulic power being supplied to the motor 29 from the station 22, which is connected to the motor by a line 32.

By remotely controlling from th surface of the water the rotation of the conduit 27, via the line 21, it is thus possible to connect th conduit 27 to any one of the vertical pipes 10*g*, 11*g*, 12*g*, etc.; i.e. to select the well in which T.F.L. servicing is to be carried out.

In the caisson 2 there is also housed a second manifold 33 ensuring safety of the oilfield and of the present installation by enabling fluid to be injected from the surface of the water into the wells. The manifold 33 is connected to the different wellheads by flexible pipelines 34, 35, etc. which are secured to the manifold 33 by tubular connectors such as 36, 37 and by pipes such as 38.

The flexible pipelines 34, 35, etc. have two main functions, which are familiar to those skilled in the art: they are used as flowlines for the injected fluid, when T.F.L. operations are performed; and they can be used as safety pipes (choke and kill) for the annular space of the producing well. Connection of the flexible pipelines 34, 35, etc. to the different wellheads 10, 11 etc., respectively, is not illustrated in Figure 1 for the sake of clarity.

The manifold 33 is connected, via a conduit 40 and a rotary coupling 41, to a flexible safety pipe 42 supported by the rotatable arm 5 (together with the flexible loading pipe 9 and the flexible circulation pipe 23), so as to permit injection of safety fluid from the surface of the water.

The caisson 2 houses a third manifold 43 by means of which the above-indicated pipes can be connected to a flare 44. Connection of these pipes to the manifold 43 may, for example, be effected as diagrammatically shown in Figure 2.

Connection of the manifold 43 to the flare 44 is provided via conduits 45 and 46 and flexible pipes 47 and 48, the latter being secured to a mooring weight 49.

The production manifold 13 is connected to the flare manifold 43 via conduits such as 39.

Moreover, each well is separately connected to the flare manifold 43 by a pipe 50.

For safety purposes, two assemblies of conduits and flexible pipes 45 to 48 are used (only one assembly being illustrated), each of these assemblies being of sufficient diameter to convey by itself, if necessary, the whole production of all of the wellheads.

Thus, each well is at the same time separately connected to the production manifold 13, to the T.F.L. circulation and well-annular space safety manifold 33, and to the flare manifold 43. The connecting pipes are of course equipped with manually operated or remotely controlled switching out valves, such as those diagrammatically shown in Figure 2 for the well 10, the other wells 11, 12 etc. being similarly connect d to the manifolds 13, 33 and 43.

In the embodim nt illustrat d in Figures 3, 4 and 4A, th shunting or switching device in the caisson comprises a barrel 28 rotatably mounted in a housing 51. The opening of the T.F.L. servicing conduit 24 into this housing is oriented along the axis there f.

The barrel 28 is provided with an internal

curved conduit 52 forming an extensi n of the T.F.L. conduit 24. By rotating the barr l 28, the conduit 24 can be connected to a conduit selected from a plurality of conduits, such as a conduit 10'*g*, opening into the housing 51 through a plurality of apertures distributed about the axis of the housing. These conduits are respectively connected on the one hand to the different wells through production and T.F.L. servicing flow lines such as 10*a*, 10*b* . . . (Figure 1) and through connecting conduits such as conduits 10*c* to 10*f* and, on the other hand, are connected to the production manifold 13. The barrel 28 is provided with positioning means which may be remotely controlled. Such positioning means comprises a motor 53 which may be connected to the central station 22 for remote control.

Claims

1. A mooring and transfer terminal for offshore hydrocarbon production from a plurality of underwater wells, the terminal comprising a watertight caisson surmounted by a rotatable arm which supports at least one loading pipe, at least one production manifold connecting the different wells to said loading pipe, at least one circulation and safety manifold connecting the different wells to a circulation and safety pipe means which is common to all the wells, said manifolds being equipped with valve means, and switching means located in a sealed chamber and enabling a conduit for introducing T.F.L. instruments to be connected to a pipe selected from a plurality of circulation and T.F.L. servicing pipes connecting the different wells both to said switching means and to said production manifold, the assembly of said manifolds and of said switching means being located in the watertight caisson, said manifolds and said switching means being connected to the different wells by flexible pipelines, and said conduit for introducing T.F.L. t ols and said circulation and safety pipe m ans being supported at the surfac of the water by the rotatable arm surmounting the caisson.

2. A terminal according to claim 1, wherein said conduit for introducing T.F.L. instruments is connected to the caisson by a rotary coupling whose axis is aligned with the caisson axis at the top of the terminal.

3. A terminal according to claim 2, wherein said switching means comprises a rotatable switching means having an axis aligned with the axis of said rotary coupling.

4. A terminal according to claim 1, claim 2 or claim 3, wherein the watertight caisson also houses a flare manifold connected to a flare located remote from the terminal by at least one flexible pipe.

5. A terminal according to any one of claims 1 to 4, wherein the caisson is supported by a structure which rests on the water bottom.

6. A terminal according to any one of claims 1 to 4, wherein the caisson is of positive buoyancy and is maintained at least partially submerged by anchoring means.

7. A terminal according to any one of the preceding claims, wherein the caisson is located in the vicinity of the water surface and supports an annular platform to which the flexible pipelines are secured.

New Claims or Amendments to Claims filed on 23 March 1979.

New Claim 8:—

8. A mooring and transfer terminal for offshore hydrocarbon production from a plurality of underwater wells, the terminal being substantially as herein described with reference to Figures 1 and 2, or Figures 1 and 2 as modified by Figures 3, 4 and 4A, of the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1979. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.